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ON THE STRUCTURE OF THE INNER EAR IN TWO PRIMITIVE REPTILES.

E. C. CASE.

In 1885 Cope¹ described the structure of the brain and the inner ear of one of the cotylosaurian reptiles, *Diadectes sp.* In this paper he figured the structure of the canals and concluded as follows: "The result of this examination into the structure of the auditory organs in the Diadectidæ may be stated as follows: The semicircular canals have the structure common to all the Gnathostomatous Chordata. The internal wall of the vestibule remains unossified as in many of the fishes and a few batrachians. There is no rudiment of the cochlea, but the vestibule is produced outward and upward to the fenestra ovalis in a way unknown in any other family of the vertebrates."

Fig. 1 shows the arrangement of the semicircular canals as given by Cope.

Among the many specimens collected from the Brier Creek Bone-bed by the University of Michigan expedition to Archer County, Texas, in the summer of 1913 there are several complete and nearly complete basi-cranial regions of the Permian or Permo-Carboniferous reptiles, *Dimetrodon* and *Edaphosaurus*. The structure of the basi-cranial region in these forms has already been described by the author,² but the recovery of this new material makes it possible to describe the condition of the ear cavity.

The specimen of *Edaphosaurus*, No. 3446 University of Michigan, probably belongs to the species *cruciger* of Cope. The bones of the ear region are undistorted and the cavity shares in the perfection of preservation. This is shown by the complete correspondence of the two sides and by the similarity of the cavity to that in less perfectly preserved specimens. If the co-

¹ Cope, *Proc. Am. Phil. Soc.*, p. 234, 1885.

² Case, Publication 55, Carnegie Institute of Washington, p. 98, 1907. Williston and Case, Publication 181, Carnegie Institution of Washington, p. 81, 1912.

ossified elements which shelter the inner ear be held in the normal position, as shown in Fig. 2, it will be seen that there is the trace of a groove running apparently horizontally from without inward; at the inner upper corner of the cavity it joins the trace of a second groove running nearly vertically. These are the marks of the anterior and posterior semicircular canals and correspond to the horizontal antero-posterior and the vertical antero-

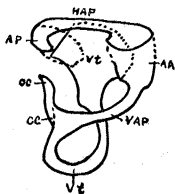


FIG. 1.

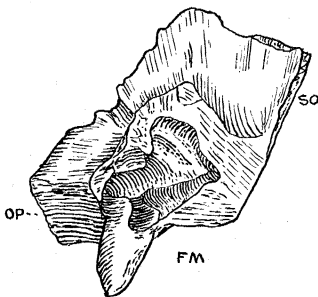


FIG. 2.

FIG. 1. Outline of the canals of the inner ear of *Diadectes* sp. From Cope. *hap*, horizontal antero-posterior canal; *aa*, anterior ampulla; *vap*, vertical antero-posterior canal; *vt*, vertical transverse canal; *ap*, posterior ampulla; *cc*, canalis communis of the vertical antero-posterior and the vertical transverse canals; *oc.os*, commune of the same.

FIG. 2. Inner view of the right otic region of *Edaphosaurus*, showing the cavity of the ear. *So*, supraoccipital; *op*, opisthotic; *fm*, foramen magnum. $\times 1$.

posterior canals of Cope's figure. Where the two canals meet there is a projection upward and forward of the cavity which probably lodged a rudiment of the apex of the sinus utriculus superior (terminology of Retzius). At the outer ends of the canal there is evidence of slight enlargements which lodged the anterior and posterior ampullæ. Just below the point of union of the two canals there is an elevation of the cavity indicating that the sinus utriculus posterior was inclined inward and forward. The cavity for the utriculus is relatively large and higher than wide. On the outer side of the broken surface of the cavity, nearly opposite the middle point there is a slight excavation indicating the position of the external canal. At the lower end of the cavity there are two extensions, one running into the paroccipital (opisthotic) bone and parallel to its axis, this lodged the

lagena and shows no evidence of any curvature; the second extension is smaller and connected with the lagena cavity, it can only be for a considerable remnant of the sacculus.

The inner wall of the otic cavity was incomplete and the fenestra ovalis opened about opposite the upper end of the lagena.

The second specimen, No. 3447 University of Michigan, is that of one of the smaller but undeterminable species of *Dimetrodon*. It is as well preserved as that of the *Edaphosaurus*, both sides being present and identical in appearance and the details of the structure further verified by other specimens. The general arrangement of the canals and cavities is the same as in *Edaphosaurus* but it is smaller. The evidence for the presence of a

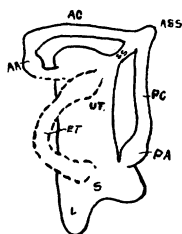


FIG. 3.

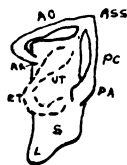


FIG. 4.

FIG. 3. Outline of the canals of the right side in *Edaphosaurus*. *ac*, anterior canal; *ass*, apex of the sinus utricule posterior; *pc*, posterior canal; *pa*, posterior ampulla; *s*, sacculus; *l*, lagena; *et*, external canal; *ut*, utriculus; *aa*, anterior ampulla. $\times 2$.

FIG. 4. Outline of the canals of the right side in *Dimetrodon* sp. Lettering the same as in Fig. 3. $\times 2$.

apex of the sinus utriculus superior is less pronounced than in the first specimen but there can be no doubt of its presence. The two lower cavities, for the lagena and the sacculus, are narrower and in less open connection. The arrangement of the canals is shown in Fig. 4.

The author is unable to bring the structure as here made out into adjustment with the figures given by Cope for *Diadectes*. In comparing the structure of the inner ear of these primitive forms with that of modern reptiles certain archaic characters are recognized. The presence of an apex to the sinus utriculus superior is notably primitive, Retzius shows it as present in certain fishes but it is not noted in the amphibians and reptiles.

The straight lagena and the relatively large remnant of the sacculus is also primitive; a large sacculus occurs in the Amphibia Ecaudata and in some lizards, as *Lacerta viridis*. The canals are entirely within the otic cavity and do not penetrate any of the adjacent bones. The lagena of the crocodile is quite elongate and the soft structures are said to show something of a twisting, the lagena of these forms is relatively shorter and broader than that of the crocodile but, of course, nothing can be said of the soft parts. The cavity of the inner ear does not exactly reproduce the membranous ear as the soft parts are separated from the wall by the perilymph but the author believes that the figures given represent a very fair approximation to the true form and proportions of the membranous ear.